Lab 3 - Energy Balance Models

In this lab, you will gain some practice using what we have learned in lecture. It will also give you some experience with a slightly more complicated type of energy balance model - a 1-D energy balance model. This model is slightly more complicated than our zero-dimensional energy balance model. It depicts a zonally-averaged latitudinal profile (that is to say that there is an single value for a latitudinal band). Unlike our simple model, it includes latitudinal distribution of short- and long-wave energy and a heat transport or *flux* from a warm band to a cold band. This model will be familiar as it is what we were attempting to create in lab when I was teaching you Excel. It doesn't use fancy things (you can see how I set up the iterative loop) so it should be usable by most later versions of Excel (I did learn my lesson).

Part 1: our zero dimensional energy balance model.

Okay this is your chance to really learn the basics of Excel if you haven't already. What I would like you to do is to set up our zero dimensional energy balance model in excel. Make it easy to use because we will change the values. Add color etc. and have some fun. I would like a copy of your model to see if it works (attach it to email or give me a disk).

1) What I would like you to do is to run this model with the cases listed in the course notes ess05. Given the albedo and emmissivity of the atmosphere listed in the notes, what temperatures do you get?

2) In the ice ages, the atmospheric carbon dioxide levels were lower and the albedo was higher. Run your model with an albedo of 0.8 and emissivity of the atmosphere of 0.70. What was the temperature in the ice age according to your model?

3) Now make a plot of how the temperature changes when you adjust the albedo from 0 to 1 with an increment of 0.05 while holding the emissivity of the atmosphere constant at the 'real world' value. Now reset the albedo to the 'real world' value and make a similar plot for emissivity. How does the sensitivity of the model to each of these parameters? Does this make sense given the governing equation (our model). What I want you to recognize is to think about how a system will act by examining the equations. It is a good skill to learn.

Part 2 - A one dimensional Energy Balance Model

I would like you to do the exercises on pp. 82 and 83 of the Energy Balance handout. The model and the questions were designed by two well-known climate modellers so I didn't think I could do any better. Also you wouldn't believe me if I did all these ice-age earth experiments. A note about answering the questions. I am not going to say do thus and so and write up the results in this way. However, when you change a parameter (e.g. Exercise 1b), record both the values of the parameters you used and the results so I can verify your results. When you answer a question, think about how you are going to write up both how you did the experiment and what your results were.

What I am trying to say and teach is this, as a scientist you need to perform experiments that can be replicated (and remember I have the same spreadsheet so I can replicate them - in the real world this is not always the case). For other scientists to replicate and understand your results, it is necessary to communicate your methodology and results to others clearly and concisely. I want to give you some experience with this. So remember, the exact experiment you perform isn't critical as long as it meets the objectives of the question (in the real world this would be you design an experiment that can adequately test your hypothesis and often there is more than one way to do this) and if you clearly demonstrate what you did and what it means.

Don't worry, I am not looking for long-winded explanations - just want you to think a little about writing up the findings. To be honest, many scientists have a problem in communicating there results clearly, I know how hard it can be.

Good luck,

Andrew